VOL. I. MARCH, 1882. No. 6.

PRICE OF THE TRANSACTIONS.

To residents of the City of New York, not members of the Academy, $5.00 per annum. To non-residents, $3.00 per annum, 40 cents per number. To resident and honorary members, they are free; extra copies, 30 cents per number.

STATE COLLEGE OF AGRICULTURE AND
LIBRARY
JUN 21 194
MANHATTAN
KANSAS

TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES.

1881-1882.

EDITOR,

ALEXIS A. JULIEN,

School of Mines Columbia College, N. Y. City.

PUBLISHED FOR THE ACADEMY,
In Eight Monthly Numbers, from October to May, inclusive.

COLLEGE OF AGRICULTURE AND
LIBRARY
JUN 21 1940
MANHATTAN
STATE - KANSAS - SCIENCE

March 6, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-five persons present.

The report of the Council was read, recommending for election, as Resident Members, the following named persons, previously nominated in due form:

FREDERICK W. DEVOE, WILLIAM E. GAVIT,
E. AUSTIN OOTHOUT, DAVID ROUSSEAU,
FERD. J. G. WIECHMANN.

They were all elected by unanimous consent.

The PRESIDENT showed a specimen, brought by Miss F. R. M. HITCHCOCK, of the peculiar blue-paper-like corn bread, used by the Zuñi people, and referred to in his lecture of February 20th.

Mr. GEORGE F. KUNZ exhibited a unique specimen of asteriated blue sapphire, from Ceylon, from the cabinet of the late Mr. MACMARTIN of this city. The specimen is a perfect hexagonal pyramid, about two inches long, and an inch wide across the base, which latter is polished and displays a very beautiful asterism The color is a fine blue, though not transparent. Also a pink-tinted apophyllite, from the new tunnel through the Bergen Hill.

Mr. NELSON H. DARTON then read the following paper:

NOTES ON THE WEEHAWKEN TUNNEL.

(Abstract.)

The railroad tunnel now being cut through the trap of Bergen Hill, near Weehawken, has excited considerable attention among the mineralogists and others in this vicinity, on account of the following minerals:

Calc Spar. This in its first form is very abundant, in quite pure and perfect crystals, often with a fine yellow tinge, but seldom transparent: the variety known as dog-tooth spar has been found in excellent condition, but only in limited quantity.

It seems peculiar to this mineral here to occur in vertical veins in the trap, while most of the other species occur in beds more or less horizontal: thus showing most of the calcite here to have crystallized from inflowing water, filling up the fissures produced by various causes. Very little of it was found in cavities in the trap, as this does not seem to be amygdaloidal here. A few almost perfect geodes and druses of so called nailhead spar have been observed, mixed with the dog-tooth spar.

Datholite has been found mostly as druses or small crystals, which were very plentiful, sometimes as large crystals, weighing from three to six grains, and in good-sized groups. I noticed that the larger the crystals were, the more vitreous their lustre and the less their transparency. They generally occur in vertical veins, at right angles to those of the calcite; when they occur in geodes, they are generally in cavities in the trap. This place is a new locality for *Hayesine*, which has, so far as I know, never been observed in any other place than in South America, and there mixed with gypsum and alum. About half a grain was secured here by scraping the cavity. On chemical examination it was found to be a borate of lime, containing but a mere trace of silica (derived probably from the scrapings of the cavity), *i. e.* Hayesine. The analysis used up nearly all obtained of this interesting mineral, and I am now eagerly seeking for more to verify my results.

Thomsonite has been reported at Bergen Hill, but I have never observed it.

Pectolite. Most of this species found here is a stellated variety, in which the fibers diverge at a greater angle than 45°. The fibers are rarely over two inches long. Masses weighing as high as three and even four pounds have been frequently found, and more or less is taken out every day, sometimes in beautifully perfect specimens.

Analcite. A few specimens have been obtained in fair sized crystals, occurring with dog-tooth spar; but it is far from being abundant.

Apophyllite has been quite abundant, generally in white crystals, more or less perfect—occasionally pink. In one case, a pocket was met with, containing, besides some white and pink apophyllite, a little of a pure purple tint. It seldom occurs alone, but usually with calcite, datholite and stellar pectolite.

Prehnite is quite abundant in traces, never in large crystals, contrary to the conditions in the Pennsylvania railroad cut. It generally occurs in small cavities, and sometimes with calcite in some of the veins.

Sphene is met with in very small quantities, disseminated through the harder trap.

Stilbite. But little stilbite has been found, and that descending from some fissures into the natrolite.

Natrolite. This has been remarkably abundant. It has been found in groups of every shape, and in various sized crystals, sometimes in nearly perfect globes fully two inches in diameter, with druses, geodes, and other forms of great beauty and perfection. Most of it has been taken out in plates four or five inches square, and about five-eighths inch thick, coming from a bed spread over a large distance.

This has an average thickness of one-half inch, and is thrice intercepted by two inch veins of calc spar, running vertically.

Heulandite. Small crystals of this species are said to have been found in some cavities.

Laumontite. Some small weathered specimens of this were found in the trap, and it was also noticed quite plentifully in traces.

Chabazite has been quite rare, a few poorly formed crystals having been found on some of the masses of apophyllite; also two excellent crystals of a pure yellow tinge, and quite transparent.

Pyrite. This species is very abundant, profusely scattered through the trap, mostly in masses, but often in excellent crystals drused on the trap.

Chlorite (?) is quite abundant, in masses and large imitation crystals, weighing five or six pounds; most of it occurs in a vein about six feet wide, within a few feet east of the pyrite locality. It is of a very dark color, quite impure and brittle, and was mistaken for coal by some parties visiting this shaft, who spread the report that a bed of coal eight feet wide had been discovered.

In closing, Mr. DARTON expressed his belief that much more fine material would still be found in excavating the space between shafts numbers one and two.

The paper was illustrated with sections of the tunnel, and by many choice specimens of the minerals described.

DISCUSSION.

Mr. CHAMBERLIN, Mr. G. F. KUNZ, and Prof. D. S. MARTIN, made remarks on the paper, expressing much interest in the variety and beauty of the minerals found in this tunnel, and making comparisons with the modes of occurrence of like species in the other Bergen tunnels.

Mr. WM. EARL HIDDEN, then read the following paper:—

A PHENOMENAL FIND OF FLUID-BEARING QUARTZ CRYSTALS.

In a paper read before this Academy in January last, on the emeralds from Alexander County, North Carolina, mention was made of certain remarkable crystals of quartz found associated with them.

These quartz crystals having shown various peculiarities rarely observed, I have thought the recounting of these phenomena would perhaps be of interest.

Crystals of quartz containing inclusions of fluids and gases are not uncommon, though crystals having such inclusions plainly visible to the naked eye are rarely found.

The quartz crystals from Western North Carolina have attained a

wide celebrity from the fact of their inclusions being of remarkable size. In some cases they were wholly unprecedented.

Mr. GEORGE W. HAWES, in an exhaustive paper upon the liquid inclusions in quartz (Am. Jour. Sci., March, 1881), mentions Branchville, Conn., as furnishing massive quartz containing a greater number of included cavities than had before been observed, of which he gave a very thorough and valuable description. He also mentions, as noteworthy, cavities two mm. in diameter, from Fibia, St. Gothard, and those of 5 mm. in diameter, from Pike's Peak, Colorado. From Herkimer county, N. Y., I have seen crystals having inclusions of even 10 mm. in their longest diameter, though such crystals were of great rarity.

Before recounting the size of the remarkable inclusions in the North Carolina crystals, it might be well to describe the position of the "pocket" in question, and its relation to the rock in which it occurred.

It was while prospecting for new veins bearing emeralds, that this pocket was unexpectedly discovered. A narrow drift of quartz fragments, with small flakes of mica, was the only exterior sign noticeable. At the head of this drift, a shaft was located and sunk to a depth of nineteen feet, with the following interesting results.

The drift, within a foot of the surface, took shape as a solid vein of quartz, which rapidly widened until, at six feet depth, it had attained a width of fully three feet. Within the next two feet, the pocket nature of the vein had become apparent, by the presence of hard lumps of red clay, within which small crystals of quartz were found.

The vein for the next foot was almost entirely composed of this hard red clay. Then, to our great astonishment, one of the miners, striking his pick very forcibly, saw it disappear wholly from his sight. Naturally he was alarmed. We all thought for a time the safest place was at the top of the shaft. Feeling from past experiences, at the locality, that a cavity of not very unusual dimensions was about to be opened to our view, we descended and resumed the work.

Procuring a long stick, I probed this cavity, so as to arrive at its size; this being a necessary precaution to work it out properly and safely.

It was thus shown that the pocket was about three feet wide, seven feet long, and at that time about three feet deep, though I could push the stick quite deeply into the clay at the bottom.

Exposing at full length the upper part of the cavity, it showed all along its sides and at the bottom stalactitic and stalagmitic forms of red mud.

The quartz, which at one time had completely lined the pocket, had, by process of disintegration, dropped into the open space below. It

was in the mud and clay in the bottom of the pocket that all the crystals subsequently found were discovered. Only at the very bottom were the walls found "in situ." This pocket differed in no respect from those commonly occurring in this region. They are all shrinkage fissures, situated in a counter direction to the strata, of very limited extent, and nearly perpendicular in position. The country rock is gneiss, trending N. N. W. and S. S. E., with a dip nearly vertical. A thick layer of soil everywhere mantles and conceals it from view. Three days of careful work, by our most trustworthy and painstaking miner, were spent in exhausting this pocket.

No mineralogist could have been more careful in preserving the angles and edges of the crystals than was this miner. Not one crystal of the hundreds taken out was in any way injured.

Over four hundred pounds of *choice* quartz crystals were obtained from this one pocket, besides the nine emeralds previously spoken of and exhibited before this Academy. Of good, bad, and indifferent, there was found in all nearly half a ton.

It was noticed that all the crystals that had been directly attached to the walls were semi-transparent and without any great development of the prismatic faces; while, implanted upon them, were crystals of great beauty and transparency, varying from citrine-yellow to dark chocolate-brown in color, and for the most part perfect in form. Two-thirds of them were perfectly terminated at both extremities and with considerable prismatic development. It was these latter that contained the fluid-inclusions.

Large plates of rosetted mica were quite common, and on them were implanted small crystals of rutile and of quartz, in rare perfection. It is to these smoky crystals, found in this pocket, that I now ask your attention. When the smoky crystals were first found, they were noticed to contain many cavities seemingly filled with a very clear and lustrous fluid. Though no bubbles of air (or gas) were observed to move in these cavities at that time, yet I knew these crystals to be the so-called "water crystals" of mineralogists.

I take pleasure in recording the remarkable size and quantity of the cavities enclosed in these crystals. The longest cavity noticed was nearly *two and one half inches long* and one quarter of an inch wide. Cavities of one inch were not uncommon, while those of one quarter inch and less were, in truth, without number.

Many of the crystals seemed to be made up almost wholly of cavities, whose walls were barely thick enough to keep them separated. Many hundred, plainly visible to the unaided eye, could have been counted in a single crystal.

For some time after these crystals were removed from the pocket, no

bubbles were noticed in any of the cavities. Some peculiar condition of the crystal, or of the atmosphere, then existing, probably prevented their formation. Later, the bubbles appeared in great numbers. A few of the crystals were, as water-bearing crystals, very remarkable in size. One weighed nearly twenty-five pounds, had both ends terminated, was of a dark brown color, and as beautiful as any we have seen from other localities. All the water-bearing crystals were large, none less than two inches in diameter and many of over three pounds in weight. The cavities were arranged parallel to each other and to either a rhombohedral or a prismatic face.

The interesting phenomena I observed in these crystals did not occur until some time after their discovery. The best crystals of the "find" were carefully selected and placed where they were considered to be safe—safe at least from molestation. That the weather would interfere, or in any way affect them, did not enter my mind.

One evening in November last (the "find" occurred on Oct. 24), I left these crystals nicely arranged at the mine, except a few of the smaller ones, which I carried to my log-cabin home, thinking the while of what a treat I had in store for mineral collectors and for science. I will frankly confess that I was inordinately proud of my "find"—verily, "pride goeth before destruction."

Now, it is of the *destruction* of these crystals that I must speak. During the night following, the mercury unexpectedly descended below the freezing point. About midnight I was awakened by several sharp reports, like the explosion of gun caps. Over a dozen of these explosions occurred.

In the morning the family were curious as to the cause of the strange explosions heard in the night. Upon the table, where the crystals had been placed the evening before, there remained now only some few sharp fragments of quartz. Pieces of the crystals, large and small, were found even fifteen feet away. In fact they were completely ruined and now possessed only the interest of reminding one of what had been. The cold had caused the water in the cavities to freeze, and consequently to expand, and then burst the crystals.

I returned to the mine with the gravest fears for the safety of the finer crystals left there. Judge of my dismay to find not one of them, even the smallest, left intact.

Crystals, that only a few hours before were rare examples of the workings of Nature's laws, were now, by these same mysterious laws, left only as an evidence of her power to do and to undo her grandest achievements. Only crumbled masses of fragments remained to tell the story.

Those with few cavities had burst, scattering large fragments, widely

separated; while those containing minute cavities lay as a heap of small fragments frozen together, *in a coherent mass*. This last feature, while being a sad reminder in one respect, is of value to science, since it shows conclusively the abundance of the fluid included; and also, what is of more importance, that this cementing ice was formed either directly from the fluids *in the crystals*, or by influences which they exerted. I do not believe this cementing ice was wholly formed by the freezing of the water contained in the cavities, but was gathered there by the attractive influence of the liquid carbon di-oxide upon being so suddenly set free; that this liquid carbon di-oxide did, by its natural affinity for moisture, create around it an atmosphere so cold that even the little dampness then existing in the air was congealed upon the crystal fragments.

As the room was a dark one, I had all these masses and larger fragments carried out and placed in the sunlight, for no other reason than to examine them more carefully. I did not anticipate from this any further developments of scientific interest. Again, believe my astonishment, as soon as the rays of the sun touched them, to notice an ebullition commence at once, which, strangely, could be heard a few feet away.

I noticed in some of these masses a very distinct odor of sulphuretted hydrogen, which was quite fugitive in some of the pieces, while constant in others. This ebullition was continued for over an hour, growing less as thawing progressed.

While holding a mass of frozen fragments, my hand would become quite wet with the melting ice. I am not in error in stating that a cub. cm. of this fluid could have been easily saved, had the proper means been at hand. It is much to be regretted that none was preserved.

Mr. A. W. WRIGHT, in a paper following that of Mr. HAWES, already referred to, gave some valuable data in regard to the composition of fluid-inclusions in quartz. The following is a summary of his results:

He found "that smoky quartz, on heating, entirely lost its color, and that this color was due to the presence of a hydrocarbon of the nature of bitumen."

Aside from this bituminous matter, which is not known to be specially connected with the cavities in the quartz, he obtains the following analysis:

Carbon di-oxide	98.33
Nitrogen	1.67

with traces of sulphuret ed hydrogen, sulphuric acid, ammonia, fluorine and probably chlorine.

The results of his investigations showed that the contents of these

cavities are chiefly water and carbon di-oxide, with a small proportion of nitrogen.

I noticed some curious phenomena in a single fragment, which had by some means escaped destruction by freezing.

This specimen had several small cavities, arranged nearly parallel to each other. At temperatures below 70° a small bubble could be plainly seen to move in each cavity, as the position of the specimen was changed. It was further noticed that the cavities contained two liquids, in one of which the bubble was wholly confined in its movements. This was seen to be the central and more transparent fluid.

If this specimen was slightly heated (the mere heat of the hand was found sufficient), the bubbles would grow gradually less until they disappeared entirely, and the fluids would unite.

On cooling, a critical temperature would be reached, when all the cavities would be filled with numberless minute bubbles, which, rushing together, would in a few seconds form to its full size the bubble originally noticed. I found that this experiment could be repeated indefinitely, without any diminution of its interesting phenomena or risk of damage to the specimen.

To Alexander county, North Carolina, and to many of the surrounding counties, we can hereafter look to produce fluid-bearing quartz crystals second in interest to those of no other region in the world.

[Mr. HIDDEN'S communication was illustrated with a very striking series of inclusion crystals, and of the fragments split off by the frost from the large crystals, as described. The pieces were in the form of large flakes or plates, parallel to the faces of the rhombohedron, and were clouded and filled with elongated or rod-shaped cavities, in immense numbers and of conspicuous size.]

March 13, 1882.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty persons present.

Prof. D. S. MARTIN, in behalf of Mr. KUNZ, exhibited a series of crystals of Diopside, from the town of DeKalb, St. Lawrence Co., N. Y. This variety of pyroxene has never before been discovered, it is believed, in this country, though long known from the two localities of Ala and Traversella, in Piedmont. Its occurrence here is therefore, a matter of much interest; and the beauty and transpa-

rency of the crystals, and their perfection of form, render them quite remarkable.

Mr. ARTHUR H. ELLIOTT then read the following paper, which was largely illustrated with specimens of the various forms of apparatus described, and by experiments:

THE METHODS OF ASCERTAINING THE SAFETY OF KEROSENE OIL.

Before speaking of the various methods that have been proposed, and are now in use, for ascertaining the safety of kerosene oil, it will perhaps be well to look over the conditions of the problem. As we all know, kerosene oil is the product of the distillation of crude petroleum. This crude petroleum is made up of a number of oily liquids having different boiling points—in other words, liquids that give off vapors at different temperatures. These temperatures vary from 65° to 400° or 500° F. From 100 parts of crude petroleum there is obtained by distillation, in round numbers:

Benzine, Naphtha, etc.,.....15–16 parts.
Kerosene Oil,.....55 parts.
Paraffine, Lubricating Oils, etc.,.....30 "

It will thus be seen that only about half the crude petroleum is fit for burning. For the benzine, naphtha, etc., are too volatile and dangerous, while the paraffine is only fit for lubricating, being too thick to flow through an ordinary lamp-wick. On account of these two facts, the kerosene oil is the most valuable product of the distillation of crude petroleum, and brings the best price in the market. Benzine is worth only half as much as kerosene oil, while naphtha and paraffine bring only one-third as much.

From these circumstances it follows that in distilling crude petroleum, the oil-refiner tries to get as much kerosene oil in his product as possible. To increase the quantity of kerosene oil given by the petroleum under treatment, the refiner may do one or both of two things. He may collect as kerosene those products which boil at either a lower or a higher temperature than good kerosene. The latter action is not so important as the former. In the last case an oil is obtained that is too thick and heavy to burn in ordinary lamps, and does not give a brilliant light. But in collecting the naphthas, which boil at a lower temperature than good kerosene, several very important results are produced. Besides adding to the quantity of kerosene in the products, these low boiling oils increase very much the brilliancy of the light given by the kerosene. Here let me state exactly what I mean by this expression. I do not mean to say that the amount of light obtainable from a given quantity of low-boiling oil is greater than that obtained

from a higher-boiling oil; but that the intensity of the light given by the low-boiling oil is greater than that given by the high-boiling oil. When these low-boiling oils are allowed to mix with the kerosene, it will be seen that they give brilliancy to the light, besides adding to the quantity of product obtainable from a given crude petroleum. This is the commercial side of the question. Now let us look at it from another standpoint—that of the consumer. These low boiling-oils give off vapors, and these vapors, when mixed even in a small proportion with air, form explosive mixtures. Then comes the problem to be solved in ascertaining the safety of kerosene oil. At what temperature does a given sample of oil give off inflammable vapors? And at what temperature must such a sample *not* give off these vapors? The latter question has already been determined and varies in different States of the Union; some consider 100° F. as sufficiently high; others require that the oil shall not give off inflammable vapors below 140° F. These temperatures have been fixed upon after experiments made with burning lamps, the details of which I will not trouble you with. Having decided at what temperature an oil shall not give off an inflammable vapor, it becomes necessary to fix the conditions under which the oil shall be tested, to determine whether it is or is not giving off this inflammable vapor. For this purpose, quite a number of pieces of apparatus have been devised; and in experimenting with these, I have reached some results that may prove not uninteresting.

The various forms of apparatus used in testing kerosene for inflammability, and the presence of inflammable vapors, may be divided into two classes: first, those in which the safety of the oil is determined in an indirect manner; and, secondly, those where the direct ignition of the vapors evolved is resorted to.

In the first class, we have the apparatus of Salleron and Urbain, of Paris; where an attempt is made to determine the presence of inflammable vapors by finding the tension of the vapor of the oil at any given temperature, the idea being that the oil containing naphtha, benzine, and the low-boiling oils, will give a vapor-tension greater than an oil without these lower products. But, unfortunately, the apparatus devised for this purpose does not give reliable results, and is of little value.

Another experimenter has sought to determine the safety of kerosene by obtaining the index of refraction of light, when transmitted through a given sample of oil. But experiments have proved that there is no direct relation between these indices and the quantity of low-boiling oil present in a sample of kerosene; indeed, the results are utterly valueless in the question of safety.

The second class of apparatus, in which a direct ignition of the

COLLEGE OF AGRICULTURE AND APP. SCIENCE
LIBRARY
JUN 21 1940
MANHATTAN
KANSAS

vapors is obtained, may be again divided into, first, those where the oil-surface is exposed, and called "open testers," and, secondly, those where the oil-surface is more or less covered, and called "closed testers."

Of these two divisions, the open testers are the first that were made and used. About twenty years ago Tagliabue devised his open petroleum-tester. It is a very simple affair, and consists essentially of a glass cup to hold the oil, which fits into a vessel of water that can be heated slowly. Having filled the glass cup with oil, a thermometer is hung in it and the whole is placed in the vessel of water; the latter is heated, and a small flame is constantly brought near the oil until a blue flash passes over the whole surface; the thermometer is now noted, and the temperature at which the blue flash appears is called the "flashing point" of the oil.

There are many details that affect the "flashing point" of an oil on this apparatus. Among these, I would mention the fact that rapid heating of the oil will lower the "flashing point," and also that the quantity of oil in the cup and the distance of the ignition-flame from the oil-surface cause the same result.

While experimenting with this apparatus, I have noted a phenomenon which has a bearing upon the safety of kerosene oil. If the apparatus is used in a very quiet room with no air currents, on approaching the oil-surface with a flame from time to time, it will be noted that, as the oil becomes heated, a temperature is attained at which the flame used for ignition becomes perceptibly larger and has a bluish outer envelope, which is very distinctly seen. This bluish exterior of the ignition-flame is very characteristic, and is noted many degrees below the flashing point of the oil in this apparatus. A very little thought will show what this phenomenon means. It will be observed that this blue extension of the flame becomes more and more marked until the oil "flashes." It thus appears that, as soon as the flame begins to enlarge, the oil is giving off inflammable vapors, but not in sufficient quantity to produce a "flash" on the surface. The vapors given off before the oil "flashes" are so light and easily diffusible that they are lost before they can form an explosive mixture with the air, for the flash is nothing more or less than a miniature explosion upon the oil-surface. Not until the vapors become so dense that they cannot diffuse rapidly, will the oil flash. The importance of this fact will be apparent later in this paper.

In testing oil with open testers, efforts have been made to produce uniform results by filling the oil-cup always to the same level, and also by various devices to obtain an ignition-flame of a given size and at a given distance from the oil surface. The ignition-flame has been replaced by the electric spark, as in the apparatus of SAYBOLT; but

neither this, nor any mechanical arrangement of flame, can overcome the difficulty of losing the lighter vapors in the open apparatus.

We will now discuss the question of "closed testers." In these an effort has been made, with more or less success, to prevent the escape of the lighter vapors lost in the open apparatus. Tagliabue, who made the first "open tester," has also devised a closed apparatus. In this he has simply placed a heavy brass cover, with a system of valves and a little chimney for igniting the vapors in, upon his open tester. The apparatus is not much better than an open tester, and has many drawbacks. First, it is extremely difficult to clean, since the valve-system below the cover dips into the oil, and it is impossible to clean the apparatus after using it with one sample of oil, and before using it with another. Secondly, the results obtained with this apparatus are but slightly lower than those obtained with a good open tester. In using the closed tester of Tagliabue it was noted that the enlargement of the flame took place at almost the same temperatures as in the open testers, the oil not flashing till many degrees above this point, a proof positive that this apparatus does not prevent the escape of the lighter vapors of kerosene. This last fact is partly due to the lack of space beneath the cover of the tester and the oil surface.

Fully realizing the importance of this whole subject, the English government appointed a commission to report upon the question; and the result of this report was an apparatus devised by Prof. ABEL, the chemist to Woolwich Arsenal. Prof. ABEL insures the slow heating of the oil by using a large quantity of water and by using an intermediate air-space between the water-bath and the oil-cup. The oil-cup has a point to be used as a filling-gauge, and is fitted with a tight cover, which carries the flame for ignition of the vapors. This apparatus certainly prevents the escape of the lighter vapors, but unfortunately the ignition lamp which is attached to the cover permanently, and is made of gun-metal, becomes very hot, and by communicating its heat to the cover raises the temperature of the oil at the sides and surface, and produces results that are too low; *i. e.*, this apparatus gives "flashing point" much lower than any other I have used, except MANN'S apparatus, which I shall speak of later.

A very ingenious type of "closed tester" is that devised by BERNSTEIN. This consists of a tube in the form of a letter U, which contains the oil to be tested. One limb of this tube is enlarged, and in it is fitted a cap containing two wicks, one central and the other at the side. Around the central wick is a tube communicating with the enlarged limb of the tube below, and the rest of the cap is closed. To operate this apparatus, the limbs of the tube are filled with water to the level of the bottom of the larger end; into the larger end a measured

quantity of the oil to be tested is introduced, the cap with the wicks is fitted, and the whole is placed in a vessel of water of the temperature at which the oil should *not* flash. When this temperature is nearly reached, the little wick on the side of the cap is lighted; and when the thermometer reaches the standard temperature, a measured quantity of water is poured into the narrow limb of the U tube. By this action the level of the oil in the enlarged portion of the tube is raised, and any vapors that may be there are forced through the tubes around the central jet. These vapors meet the flame of the jet already lighted, they become ignited, and by so doing ignite the central wick.

It will be seen that as soon as the oil-level is raised, it is not easy to repeat the experiment; hence the apparatus is only intended to determine at what temperature an oil does *not* give off vapors, and not to determine its flashing point. One important difficulty in this apparatus is the fact that the central wick will not ignite with certainty every time that an oil is giving off inflammable vapors. For I have repeatedly failed to ignite the central wick in an experiment, and on removing the cap have immediately obtained a flash with the oil in the cup. When the central wick ignites, this apparatus gives results that are generally higher than with open testers, which may be due to the fact that the vapors must have a certain density before their ignition will inflame the central jet.

One of the best of the recently devised forms of "closed testers" is that used in the State of Wisconsin. Its construction is very simple, but it embodies some features that make it stand before those I have already mentioned. It consists of a copper water-bath, a copper oil vessel, and a cover with two holes in it, through one of which passes a thermometer.

The oil-cup holds a good quantity of oil, and there is considerable space above the oil-surface for the accumulation of the vapors. Its use is very simple, and consists in heating the oil slowly by means of the water, the flash being obtained by introducing a small flame into the second hole of the cover. The apparatus is not costly; it is easily used and cleaned, and the results obtained are quite near the truth.

Some years ago Mr. MANN conceived the idea that the best way to test oil is under the same conditions that obtain in using it. For this purpose he devised a metallic lamp, about the same size as an ordinary kerosene one; he replaced the usual wick-holder by a tube, which could be loosely closed with a plug. The side of the lamp contained a valve opening inwards, through which a flame could be introduced to ignite the vapors. The thermometer was placed in a closed tube fitted into the side of the lamp. This lamp was placed in a water-bath that fitted it, and the whole heated slowly. A small flame (a gas-jet) was

introduced from time to time, until the plug was driven out by the force of the explosion of the mixture of vapors and air within.

At first sight this appears to be the acme of oil-toilers; but, alas, it has several important faults. It is not a matter of indifference how the plug is placed in the tube. If it is too tight, it will not be ejected by the explosion, and the flame will force itself out at the side valve. It is also important that the instant of right admixture of vapors and air should be the instant that the flame is introduced. For if the air contains more vapors than will form an explosive mixture, simple combustion at the valve, and not explosion, is the result. By introducing the electric spark as a means of ignition, the difficulty of admixture may be overcome; but the force necessary to eject the plug must always be a difficulty.

In this paper I have not been able to discuss all the various apparatus used for testing kerosene oil; but I have taken some of those most used, and that are types of others.

Yet one other apparatus remains to be noticed, and this is the "electric closed tester," devised by Mr. PEASE, of Buffalo. In this apparatus we have the usual oil-cup and water-bath. But the oil-cup has a cover, and an overflow tube to insure the level of the oil remaining the same during the process of heating; since the heating causes expansion of the oil and thus raises the level. Into the cover of this tester are fitted two wires, between which a spark from an induction-coil may be passed. The usual outfit of thermometers completes the apparatus.

This apparatus is very nicely made, and the overflow-tube is an important device, especially with the heavier oils. But, in working with this tester, I was surprised to obtain results very little better than with an open tester. This is due to the fact that the spark-wires are in the centre of an opening in the cover, and that this opening is so large that the vapors escape around the sides without being ignited. To prove this, I covered the opening with a small piece of glass, and obtained a flash at a much lower temperature, because the vapors could not escape.

For the sake of comparison, I have tabulated the results obtained with the various apparatus, and the quantities of oil used in each.

	Oil Used.	Flash.
Tagliabue's (open)	2 ounces	97° Fah.
Saybolt's (open)	2⅓ "	99 "
Tagliabue's (closed)	3 "	93 "
Abel's (closed)	2½ "	76 "
Bernstein's (closed)	1¾ "	100 "
Wisconsin (closed)	5 "	86 "
Mann's (closed)	10 "	75 "

STATE COLLEGE OF AGRICULTURE AND ... LIBRARY JUN 21 1940 MANHATTAN KANSAS

Looking at the above table, and rejecting the results from the apparatus of both BERNSTEIN and ABEL, which are faulty in construction, the following conclusions may be drawn:

1. Open testers are not to be recommended, since the light vapors are lost.

2. Closed testers should be so constructed as to prevent the loss of vapors, and to give conditions that obtain in burning an ordinary kerosene lamp. This last fact is important in connection with the quantity of oil used. A glance at the table reveals the fact, that the greater the quantity of oil in the apparatus, the lower the "flashing-point." It is ridiculous to make a test on two ounces of oil, which is used in a lamp holding twelve or more ounces. The test should be made upon at least ten ounces of oil, and in an apparatus where the personal equation of the operator shall have little or no influence.

The paper of Mr. ELLIOTT was discussed at some length by Prof. SEELEY, Dr. NEWBERRY and Mr. WOLCOTT.

March 20, 1882.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The larger hall was entirely filled.

Ordinary business of detail was omitted; and the regular lecture of the monthly course was delivered by Prof. JOHN K. REES, on the subject of—

SOME RESULTS OF PHOTOGRAPHY AS APPLIED TO ASTRONOMY.

(Abstract)

We find Mr. NORMAN LOCKYER, of England, stating in his book on "Star-gazing," that "celestial photography was founded in the year 1850 by Prof. BOND of Cambridge, Mass., who obtained daguerreotypes of the moon at about that date." This appears to be an error. Dr. HENRY DRAPER, of this city, in a paper published by the Smithsonian Institution, tells us that the first photographic representations of the moon ever made, were taken by his father, the late Prof. JOHN W. DRAPER. Prof. DRAPER presented his specimens to the New York Lyceum of Natural History. In the minutes of that body we find the following memorandum:—

MARCH 23, 1840.—Dr. DRAPER announced that he had succeeded in getting a representation of the moon's surface by the daguerreotype. The time occupied was *twenty minutes*, and the size of the figure

about one inch in diameter. DAGUERRE had attempted the same thing, but did not succeed. This is the first time that anything like a distinct representation of the moon's surface has been obtained.

(Signed) ROBT. H. BROWNNE, *Secretary.*

Since that time celestial photography has been immensely improved. When we read the names of the men who have done the most to develop this beautiful branch of investigation, we find that a member of the New York Academy of Sciences stands at the head.

To LEWIS M. RUTHERFORD the world of science owes a great debt for his untiring perseverance and ingenuity, shown in developing Celestial Photography to such a point that it now bids fair to replace, in a great measure, all other methods of observation.

[The general outlines of the method of photography were given, the several obstacles to be overcome were mentioned, and the plate-holder illustrated and explained. The necessity of having a good clock was shown. The differences between reflectors and refractors for photographic work were illustrated, several advantages of each kind of instrument being mentioned.]

As a piece of interesting history relating to our subject, let me quote from an English work, Chambers' Descriptive Astronomy.

"To an American we are indebted for the best pictures of our satellite yet produced, and it is difficult to conceive that anything superior can ever be obtained; and yet with the fact before us that De la Rue's are better than anything taken in this country, so it may prove that even the marvellous pictures of Mr. RUTHERFORD may be surpassed."

Mr. RUTHERFORD appears, from a paper in SILLIMAN'S *American Journal of Science* for May, 1865, to have begun his work in lunar photography in 1858, with an equatorial of 11¼ inches aperture and fourteen feet focal length, and corrected in the usual way for the visual focus only. The actinic focus was found to be $\frac{1}{10}$ of an inch from the visual. The instrument gave pictures of the moon, and of stars down to the fifth magnitude, satisfactorily, when compared with what had been done previously, but not sufficiently so to satisfy Mr. RUTHERFORD. After trying to correct for the photographic rays by working with combinations of lenses inserted in the tube between the object and the sensitive plate, he commenced some experiments, in 1861, with a silvered mirror of 13" diameter. This was mounted in a frame and strapped to the tube of the refractor. Mr. RUTHERFORD enumerates several objections to the reflector for this kind of work, but admits the advantage of coincidence of foci. The reflector was abandoned for a refractor, specially constructed, of the same size as the first one and of nearly the same focal length—about $\frac{1}{10}$ shorter. This instrument was corrected for the chemical rays only, and was, therefore, worthless for

seeing. The glass was completed in December, 1864; but it was not until March 6 of the following year that a sufficiently clear atmosphere occurred, and on that night the negatives were obtained, from which the pictures of the moon that we shall see to-night were taken.

But even with this method Mr. RUTHERFORD was not satisfied. Coming back to the 11¼-inch object glass which he had used at first, he determined to see whether or not the addition of a meniscus lens, outside the front lens, would not give him the requisite shortness of focus and bring the actinic rays absolutely together. By this arrangement he got a telescope which can be used for all purposes of astronomical research, and he has also eclipsed all his former efforts.—(*Lockyer, Star-gazer*, p. 467.)

In the series of moon-pictures by RUTHERFORD and DRAPER, we have a complete map of the moon; not only are the grander outlines clearly shown, but many of the smaller details. [Illustrations were given of the work of BEER and MAEDLER, of Germany, and SCHMIDT, of Athens. Comparisons were made between the photographs and eye-drawings, and the use of photography in detecting changes in the moon was alluded to.]

In taking sun-photographs, it becomes necessary, on account of the dazzling brightness of the sun's light, to make the exposure practically instantaneous. Some astronomers reduce the aperture of their telescopes, by suitable diaphragms, to about two inches diameter, thus cutting off a great deal of the sun's light. Even then, the time of exposure is less than the three hundredth part of a second. [The method of making these quick exposures by what is called the instantaneous slide was explained. A series of pictures of the sun, by MR. RUTHERFORD, was then thrown on the screen. The use of photography, in studying the mottled surface of the sun, was illustrated by photographs from RUTHERFORD and JANSSEN, and drawings from NESMITH, SECCHI, HUGGINS and LANGLEY.]

There are times when the sun shows us surroundings which it is impossible to see ordinarily, as at total solar eclipses. Such a time is an exciting moment, the eclipse lasting from a few seconds to some six or eight minutes only, and the average time being such that altogether we have only a few days in a century for observation. Drawings made by two observers, side by side, differ very peculiarly. Photography assists us immensely in our study, and some of the best observations of eclipses have thus been made. [Illustrations of the photographs of 1851, 1860, 1869, 1870 and 1872 were then thrown on the screen and explained. A full description was given of the apparatus used by the American parties, in photographing the transit of Venus, and some illustrations of actual photographs taken were shown.]

But not only are we able, by the aid of photography, to study the members of the solar system, but it is possible thus to investigate the relations of the immensely far-off stars, and even to determine their distances.

In the heavens we discover with a telescope that many stars are changing their positions and distances with respect to their near visible companions; and investigations have been made proving that some of these revolve about the others as centres, forming systems of their own, like our solar system.

The measurements required for this work are numerous and delicate, and can be made only on nights when the seeing is very fine, by a skillful observer. Mr. RUTHERFORD has adopted a method of photographing a cluster of stars, or a double star, in such a way, that the plates can be laid away and measured by a person simply trained in the use of a micrometer. These plates may be taken at large intervals. On comparing the measurements, a decision can be reached as to whether any stars have moved with respect to the others.

Let me describe Mr. RUTHERFORD'S method:

First, a wet plate is exposed for four minutes. This gives stars down to the tenth magnitude. But there may be points on the plate which are not stars; hence a second impression is taken on the same plate, after it has been slightly moved. All points now doubled are true stars. Now for measures of arc. After this second photograph is taken, the clock is stopped. The now moving stars down to the fourth magnitude are bright enough to leave a continuous line; the length of this, in a very accurately known interval, say two minutes, enables the arc to be calculated. Next comes the mapping. The negative is fixed on a horizontal divided circle on glass, illuminated from below. Above it is a system of two rails, along which travels a carrier with two microscopes, magnifying fifty diameters. By the one in the centre, with two cross-wires in the field of view, the photograph is observed. By the other, armed with a wire micrometer, a divided scale, on glass, which is fixed along the rail, is read. Suppose we wish to measure the distance between two stars on the plate. The plate is rotated so that the line which joins them coincides with that which is described by the optical axis of the central microscope (marked by the cross-wires), when the carrier runs along the rails. This microscope is then brought successively over the two stars, and the other microscope over the scale reads the nearest division. Hence then, the fixed scale, and not a micrometer screw, is depended upon for the complete distance. In this way the distance between two stars on the plate can be measured to the $\frac{1}{25000}$th part of an inch.

By the measurement of such plates, we may hope to add a great deal to our knowledge of the stellar systems.

March 27, 1882.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

Mr. GEORGE F. KUNZ showed specimens of marine shells (*Pectunculus*, etc.,) from "Aztec" ruins, near Salt River, Arizona, curiously cut or ground into ornamental articles, by the ancient occupants of that region.

The PRESIDENT read some notes furnished by Dr. J. B. HOLDER, in reference to the whale on exhibition at the foot of Wall street, recently captured off Montauk. He was disposed to regard it as a specimen of *Eubalæna Sieboldii*, a species belonging to the North Pacific; and, in this case, it would seem that the animal must have reached this coast by making the "northwest passage."

Mr. ARTHUR H. ELLIOTT reported for the committee appointed to prepare a memorial of the late Dr. HOLLEY; he read the following paper, which was adopted by the society and ordered to be published in the transactions:

In Memoriam.

ALEXANDER LYMAN HOLLEY, the widely esteemed fellow of the New York Academy of Sciences, was born at Lakeville, Conn., July 20, 1832. His father was once Governor of the State, and still lives at Lakeville, at the age of 77. The son, at an early age, conceived a passion for the profession that was ultimately to make him famous, and learned the trade of a machinist. He was prepared for Yale College; but, having a scientific turn, he entered Brown University, and graduated from the scientific department in 1853, at the age of twenty-one. His graduating address, on "Motive Power," shows that he was still true to his first tastes for engineering and its branches. After graduation, he entered the Corliss Works at Providence, R. I., in the double capacity of workman and student; and afterward became a locomotive engineer on the Stonington and Providence railroad. From this position, he went to the New York Locomotive Works of BREESE, KNEILAND & CO., at Jersey City, as draughtsman; and became a contributor to several technical journals. In 1856, he was owner and editor of the *Railway Advocate*. In 1857, he went to Europe to study railroad practice there; and in 1858, he published, in connection with ZERAH COLBURN, their celebrated book on European railroads. During this time Mr. HOLLEY was an active professional writer for the New York *Times*, and foretold at that day the supersedure of the side-wheel

by the screw, in ocean steamers. In 1859, he went to Europe with Mr. H. J. RAYMOND, as correspondent for the New York *Times*, and met BRUNEL and SCOTT RUSSELL, the projectors of the "Great Eastern," which vessel he studied, and returned to America in her on the first trip. When writing for the New York *Times*, it was under the *nom de plume* of Tubal Cain.

About this time we also find him editing the *American Railway Review*; and in 1860, he published "Railway Practice." In the year 1862, he went to Europe to investigate ordnance and armor, in behalf of Mr. E. A. STEVENS of Battery fame; and the result of this visit was a book on these subjects published in 1865, which was translated and published in France. During this time (in 1864), he contributed 1000 definitions and several hundred figures to Webster's Dictionary.

While in England, studying ordnance and armor, he met Mr. HENRY BESSEMER, and became interested in the process of making steel, which was to render his name most famous, and give America the foremost position in the world in the manufacture of this indispensable material.

BESSEMER first announced his discovery of making steel by blowing air through molten iron, in the year 1856, at the Cheltenham meeting of the British Association for the Advancement of Science; and HOLLEY was among the first to appreciate its value. In 1862, he first became identified with this process of manufacture; and his connection with it became a series of engineering triumphs almost without parallel, till his death.

The first steel works in the United States to use the BESSEMER process were those at Troy, and the first ingot of metal was cast in 1864. Three years later the works at Harrisburg were built by Mr. HOLLEY, and he managed them till 1869. He rebuilt the Troy Works and planned the works at North Chicago and Joliet, Ill., the Edgar Thomson Works at Pittsburg, and the Vulcan Works at St. Louis. From the trial ingot cast at Troy in 1864, the industry has grown until the product of a year now amounts to more than a million of tons. And this gigantic industry owes much of its success to the active brain and patient industry of MR. HOLLEY.

In the year 1877, he was made consulting engineer to the Bessemer Steel Association of America, and became the idol of the manufacturers. He was a fine speaker and a ready wit, and there was that in his discourse that made his sentences always pleasing to the ear. From 1875 to 1876, he was President of the American Institute of Mining Engineers. During the following year, he was Vice-President of the American Society of Civil Engineers; and, in 1879, he organized and became first President of the American Society of Mechanical Engin-

NEW YORK ACADEMY OF SCIENCES,

Late LYCEUM OF NATURAL HISTORY.

The Meetings of the Academy are held at the rooms, No. 12 West 31st Street, on Monday evening of each week, at 8 P. M., from October to May, inclusive, and are open to the public; on the evenings devoted to Public Lectures, admission is only by tickets, which are free, on previous application.

OFFICERS OF THE ACADEMY.

PRESIDENT:

JOHN S. NEWBERRY, *Columbia College, N. Y. City.*

VICE-PRESIDENTS:

BENJ. N. MARTIN. ALEXIS A. JULIEN.

CORRESPONDING SECRETARY:

ALBERT R. LEEDS, *Hoboken, N. J.*

TREASURER:

JOHN H. HINTON, 41 *West 32nd St.*

RECORDING SECRETARY:

OLIVER P. HUBBARD, 65 *West 19th St.*

LIBRARIAN:

LOUIS ELSBERG, 614 *Fifth Avenue.*

COUNCIL:

DANIEL S. MARTIN, ALFRED C. POST,
GEORGE N. LAWRENCE, WILLIAM P. TROWBRIDGE,
THOMAS EGLESTON, LOUIS ELSBERG.

FINANCE COMMITTEE:

T. B. CODDINGTON, PHILIP SCHUYLER, THOMAS BLAND.

COMMITTEE OF PUBLICATION:

D. S. MARTIN, J. S. NEWBERRY, G. N. LAWRENCE,
A. R. LEEDS, W. P. TROWBRIDGE.

ANNALS OF THE NEW YORK ACADEMY OF SCIENCES.

The "Annals," published for over half a century, by the late Lyceum of Natural History, will be continued under the above name by the NEW YORK ACADEMY OF SCIENCES. It is proposed to issue four numbers every year, each number to consist of not less than thirty-two pages (octavo), with or without plates. Price of Yearly Subscription to non-residents of New York City, $3.00, payable in advance, or $1.00 per number; to resident and honorary members, $2.00, or 60 cents per number; to residents of New York City, not members of the Academy, $5.00. The Academy has for sale a number of back volumes of the Annals, each containing twelve or more numbers; the price per volume is $4.00 with uncolored plates, or $5.00 with colored plates.

The Academy has established a Publication Fund, contributors to which, in the sum of $100 at one time, are entitled to all the scientific publications of the Academy, both Annals and Transactions, appearing subsequently to the payment of their contribution.

Communications in regard to both Annals and Transactions should be addressed to

Prof D. S. MARTIN,

Chairman of Publication Committee, 236 *W. 4th St.,*

NEW YORK CITY.